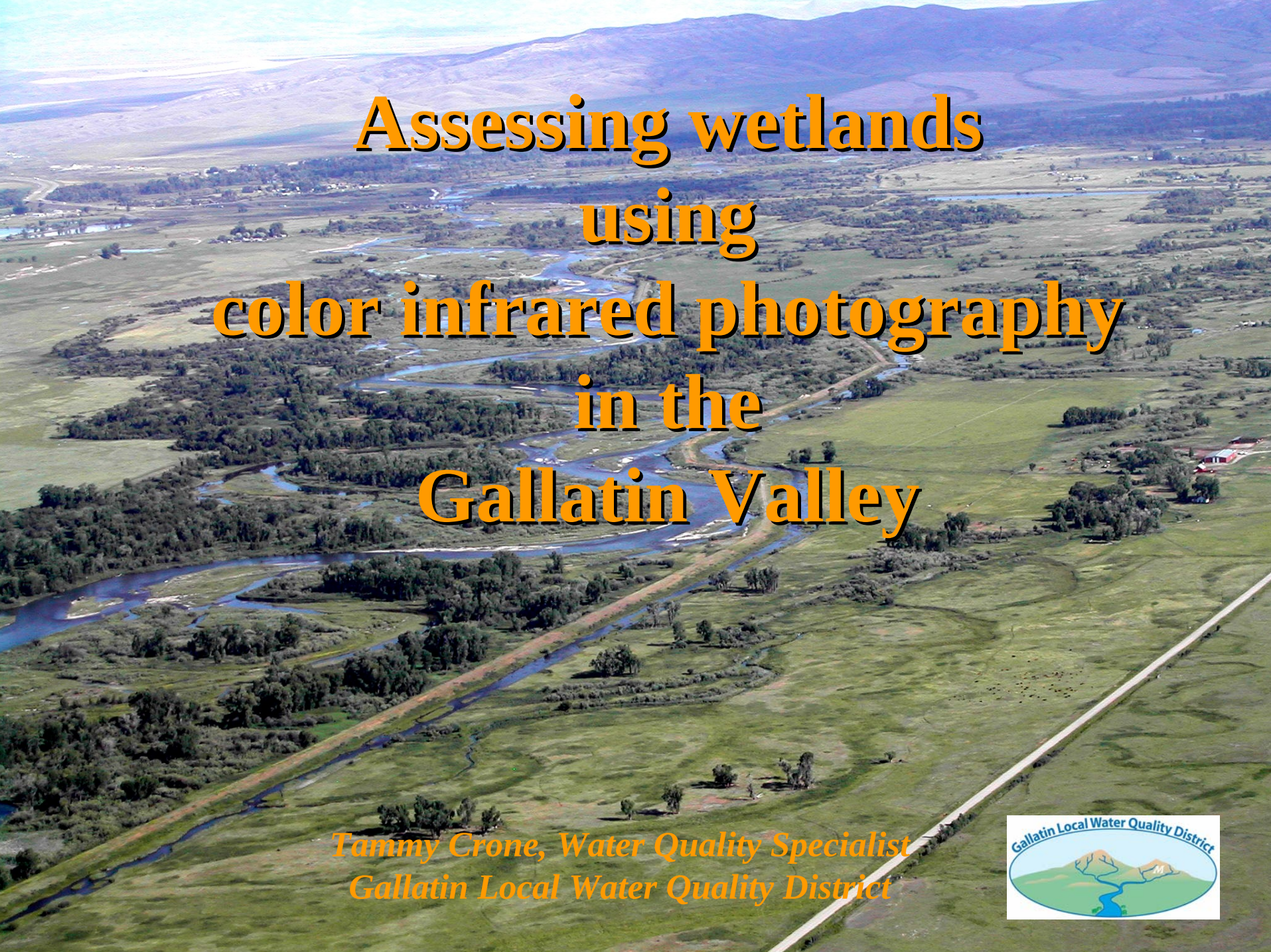


Assessing wetlands using color infrared photography in the Gallatin Valley

Tammy Crone, Water Quality Specialist
Gallatin Local Water Quality District

Project Funding

- Sponsored by the Montana Department of Environmental Quality with funding provided by the U.S. Environmental Protection Agency.

Matching Funds and In-Kind Support

- Gallatin Local Water Quality District
- Gallatin County GIS Department
- Gallatin County Planning Board
- Gallatin Co. Disaster & Emergency Services
- City of Bozeman Planning Department
- Bozeman Watershed Council

Project Goals

- Establish a GIS database of historic and current wetland and riparian resources.
- Identify wetland and riparian areas for preservation and restoration.
- Provide educational information on the losses of these resources and the benefits of protecting and restoring them.

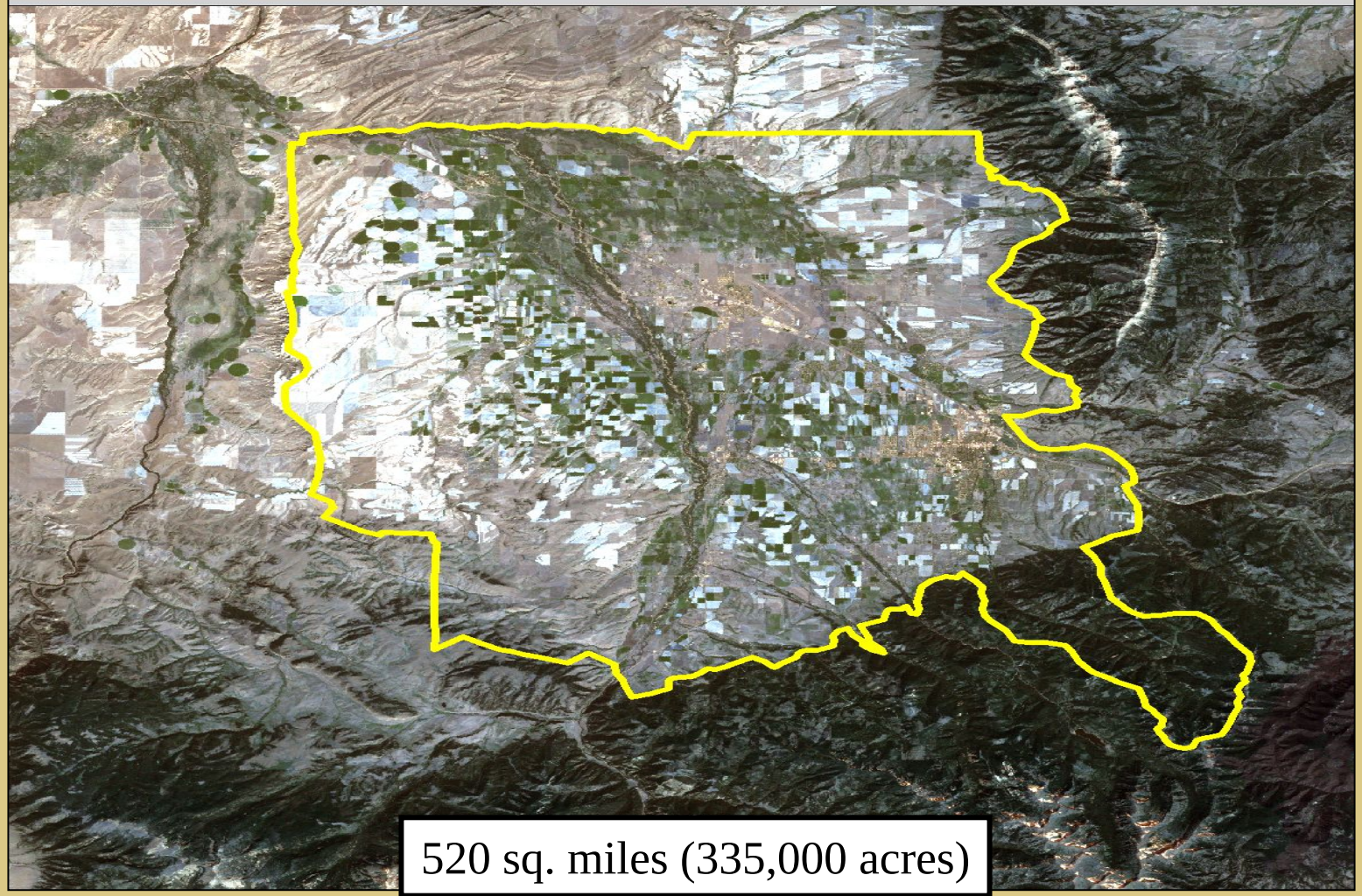
Questions Addressed…

- **How** are wetland and riparian areas currently distributed in the Gallatin Valley?
- **What** is the maximum historical extent of wetland and riparian areas in the Gallatin Valley?
- **Where** and how have land use changes impacted these resources?

Gallatin Local Water Quality District

District covers 815 mi^2

Wetland Project Area in Gallatin Valley



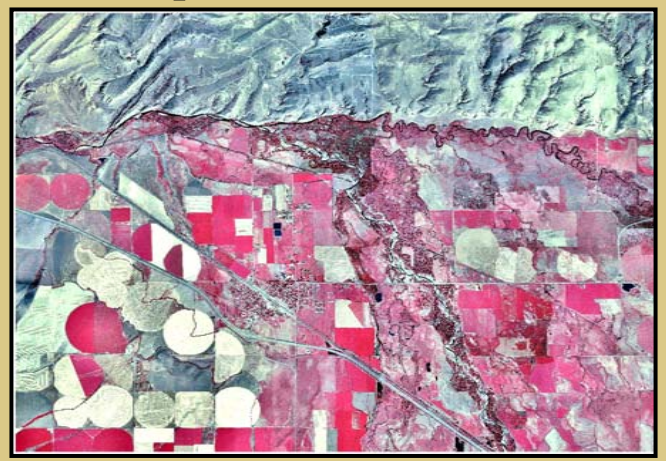
Traditional Wetland Identification Techniques

On-site analysis

- Time consuming
- Expensive
- Inefficient for large areas
- Accessibility problems on private lands

Aerial Photo Interpretation

- Synoptic view of study area
- CIR imagery is widely applicable data resource
- Allows equally intensive study for both private and public lands
- Enables rapid analysis of large landscapes

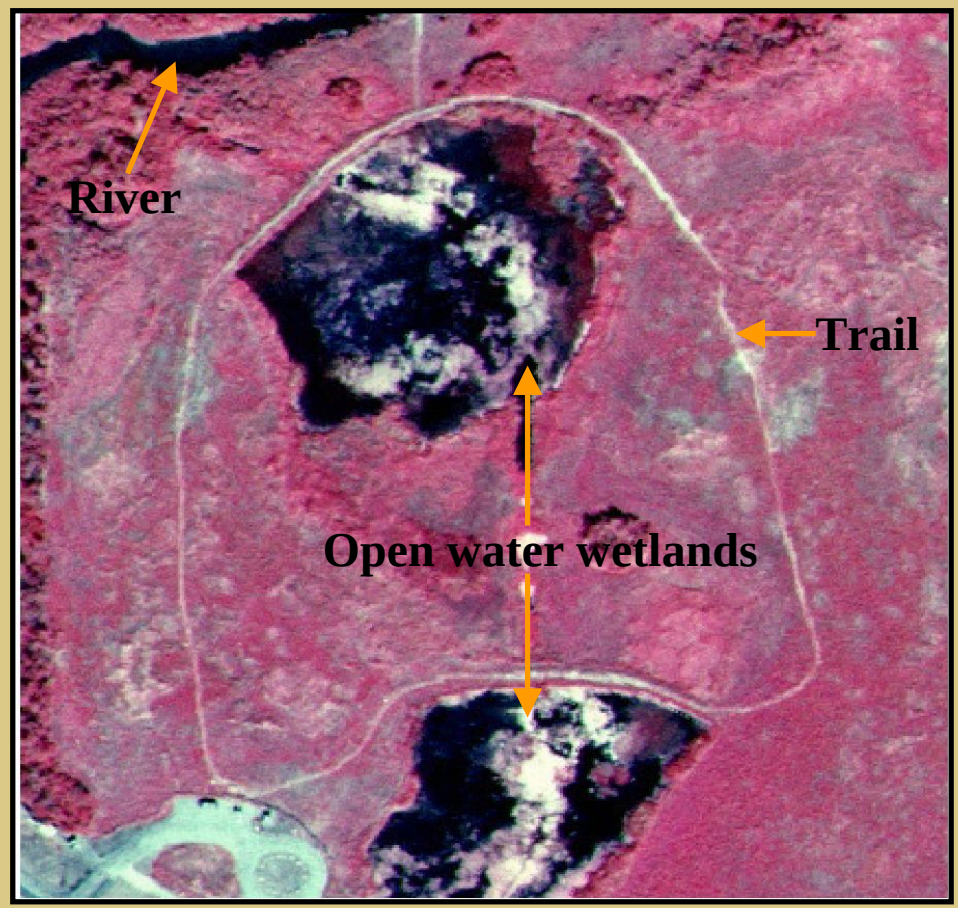


Project Limitations

- GIS mapping of current wetland and riparian resources represents a reasonable effort to **inventory** a large area with limited funds.
- The wetland areas mapped are approximate. ***They do not represent delineated jurisdictional wetlands.***
- Mapping of historical wetland and riparian areas is based on several data sources, and represents a reasonable attempt to determine the **maximum** extent of these resources in the past.

High Resolution Digital CIR Registered Ortho-photography

- Primary resource used to construct a GIS database of inventoried wetland and riparian resources.
- Used to aid in comparison of historical photographs and current conditions.
- A resource for future analysis of changes to wetland and riparian resources.
- Existing spatial datasets can be directly overlaid on the CIR imagery.



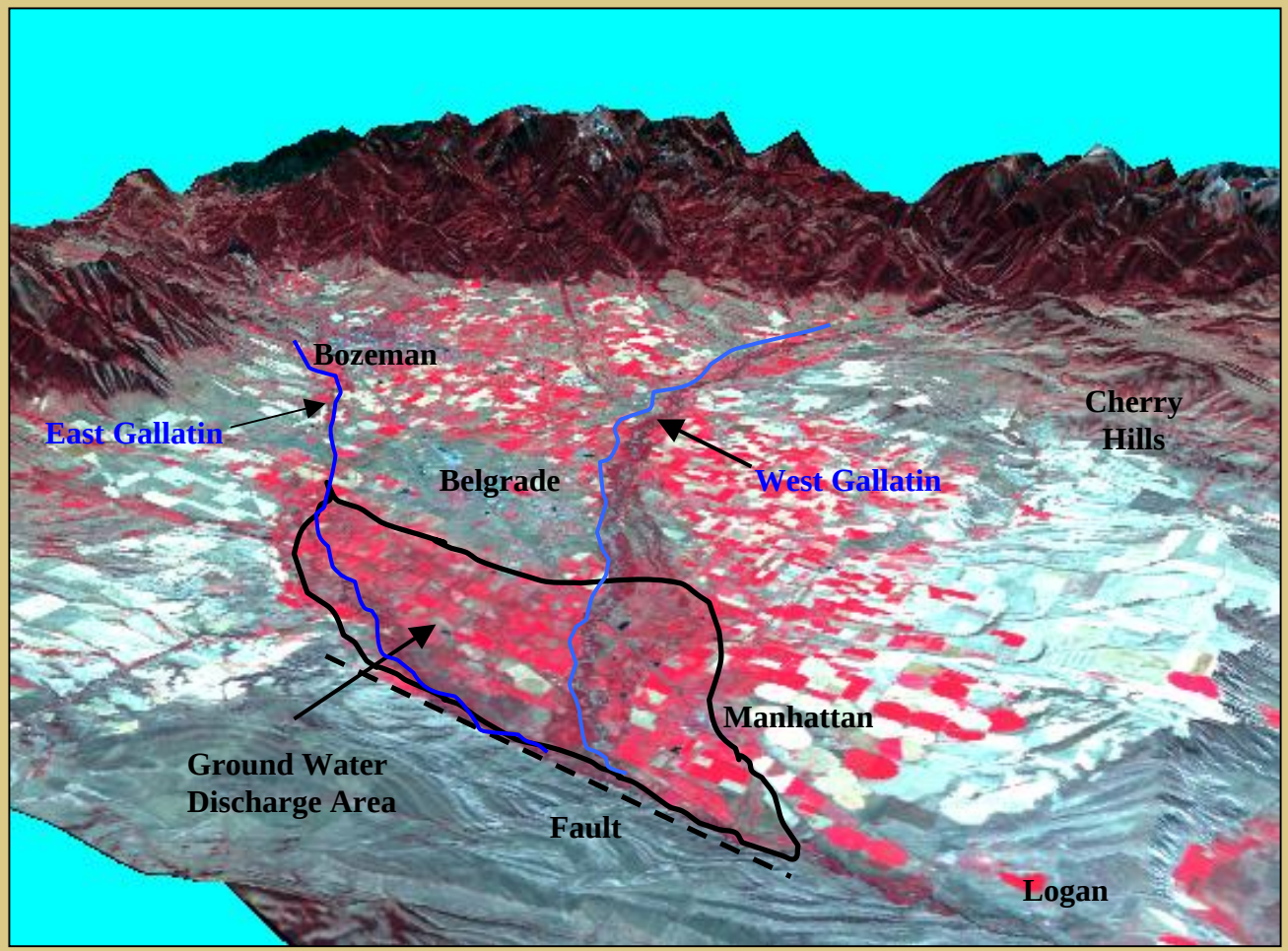
Aerial Photography Used to Develop CIR Imagery

- Pictures taken at 12,000 feet on Sept. 9, 2001
- 14 flight lines, and 252 photographs
- Film developed as color positive (looks like print)
- Resulting photo scale is approx. 1:24,000
- 60% end lap and 30% side lap between photos allows for stereo viewing of contact prints

Converting Photos to Digital Images

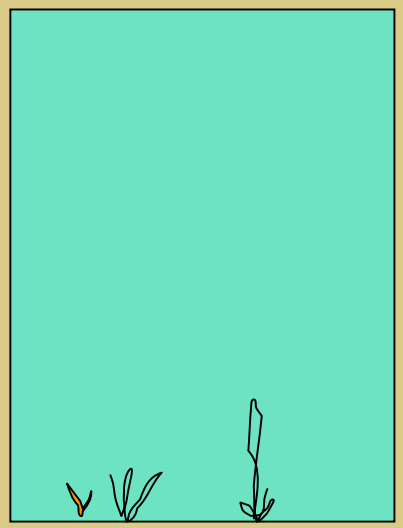
- Film positive (not contact prints) were scanned.
- Scanned with ZI Imaging Photoscan TD-310.
  - A high resolution photogrammetric scanner.
  - Frames scanned at 907 dpi (28 micron pixel size).
  - Saved as TIFF images, 209 megabytes/frame.
  - Required 85 compact discs/12 DVDs to store raw scan files.
  - If possible, would require 36,000 floppy discs to store!
- Image pixel size is 2.2 ft (0.66 m) on ground.
  - Based on original photo scale and scan settings
- Images were “dodged” when scanned to reduce effects of shadows and bright spots.

Gallatin Valley – View to SE



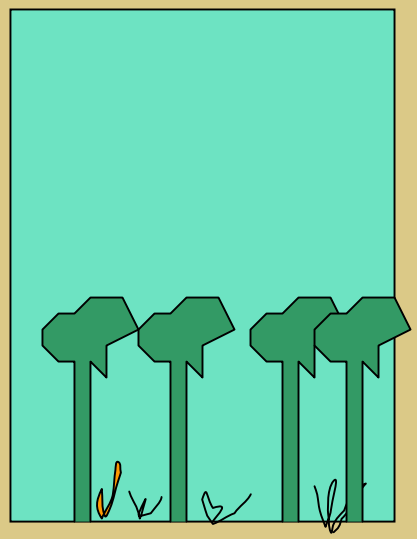
Polygon Types for Inventory

Wetland Layer



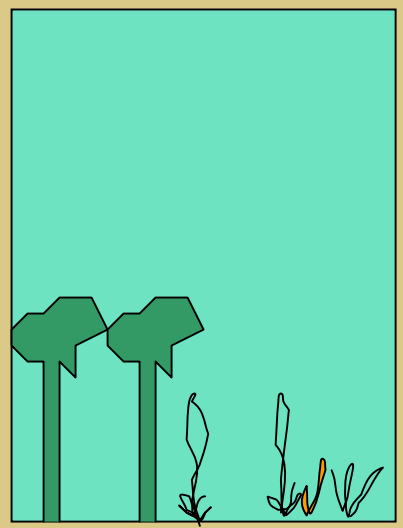
September 2001

Riparian/Wetland Mixed Layer



September 2001

Maximum Extent of Wetland and Riparian Areas Combined

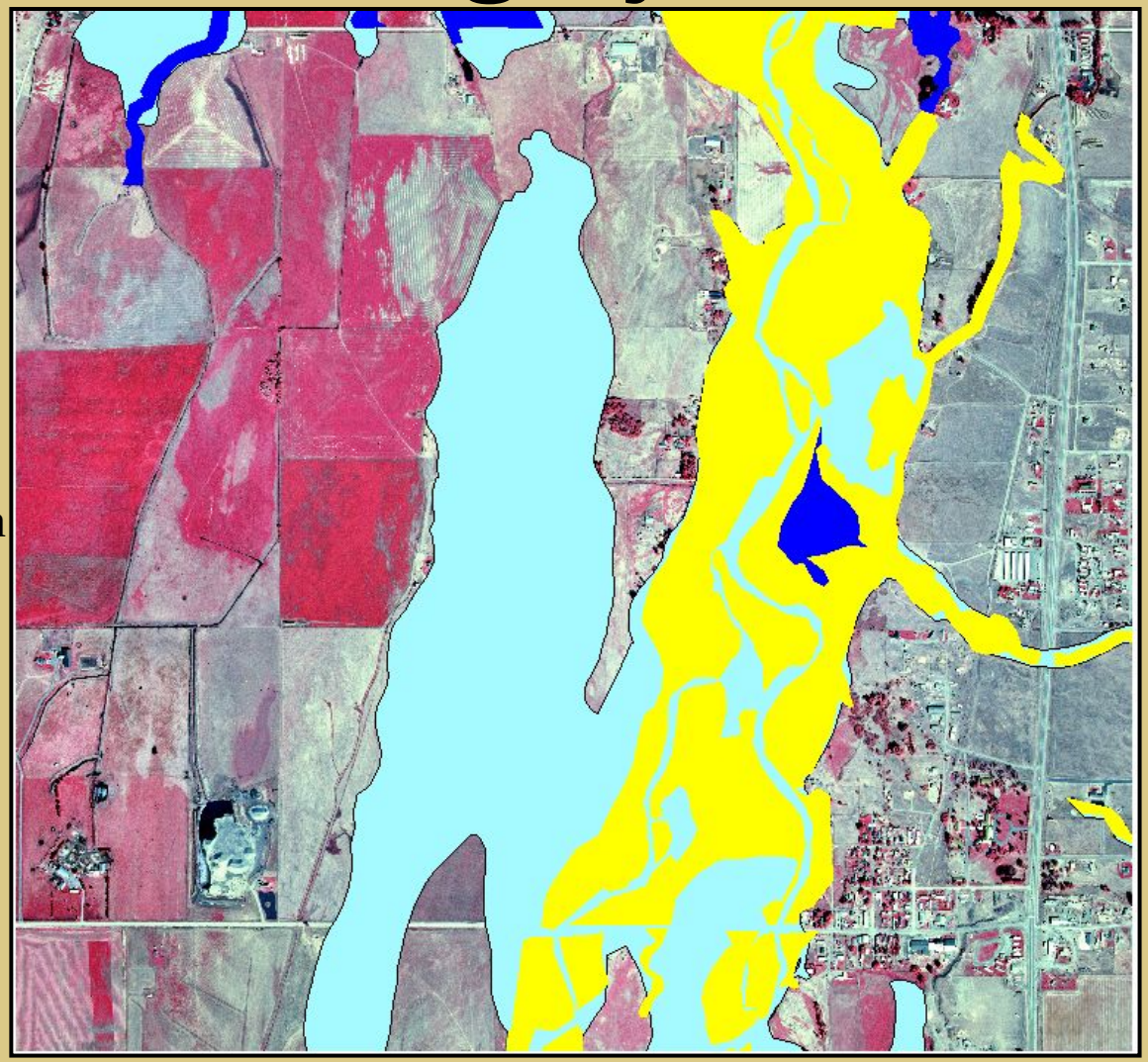


Pre-1800

Examples of Polygon Types on CIR Imagery

Map Legend

- Riparian/Wetland Mixed (Sept. 2001)
- Wetland (Sept. 2001)
- Maximum Historical Wetland and Riparian Combined



Aerial Photo Interpretation

- Land cover identification
  - Contrasting color, texture, tone
  - Landscape indicators (ie. drainage and land-use patterns)
- Reviewed documents for known wetlands
  - County subdivision documents
  - Existing conservation easements
  - *Bozeman Critical Lands Study (1998)*

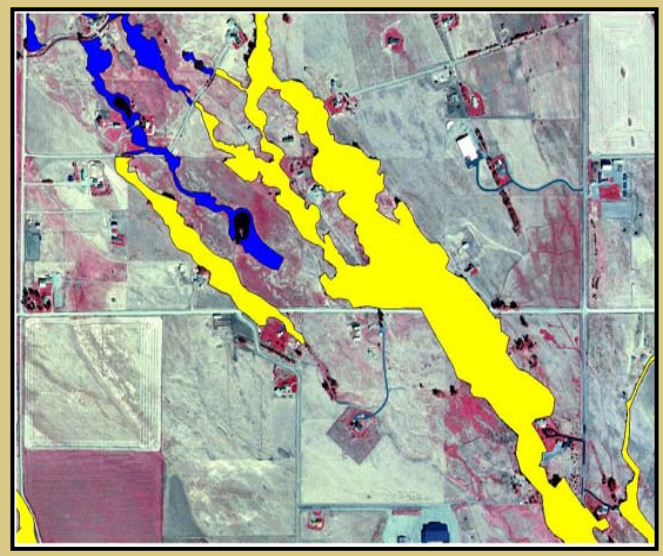
- Utilized existing data layers
  - Hydric soils
  - Irrigation ditches
- Ground verification
  - Sites visited during mapping process
  - 240 Ground-truth sites after initial mapping completed
  - Other areas surveyed by low altitude flights

Mapping Conventions

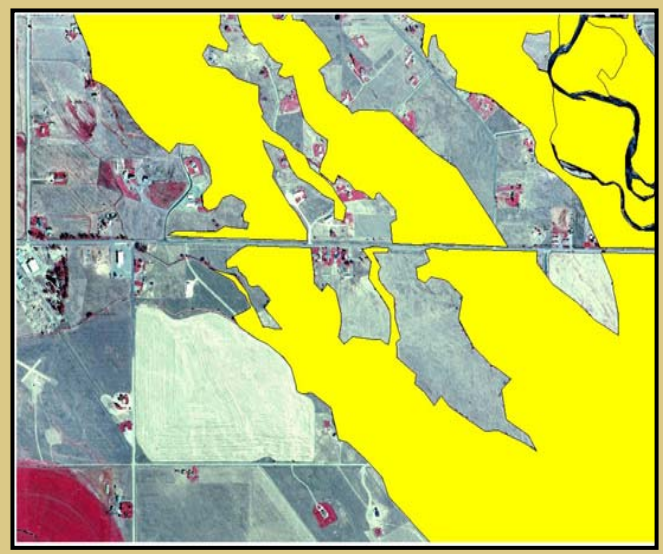
- **Minimum mapping unit** = 0.5 acre
  - Smaller sites were mapped if they could be clearly identified on the CIR imagery. Many of these smaller sites probably missed.
- **Split and continuous polygons**
  - Bisecting features (roads, residential developments, constructed ponds)

Mapping Conventions

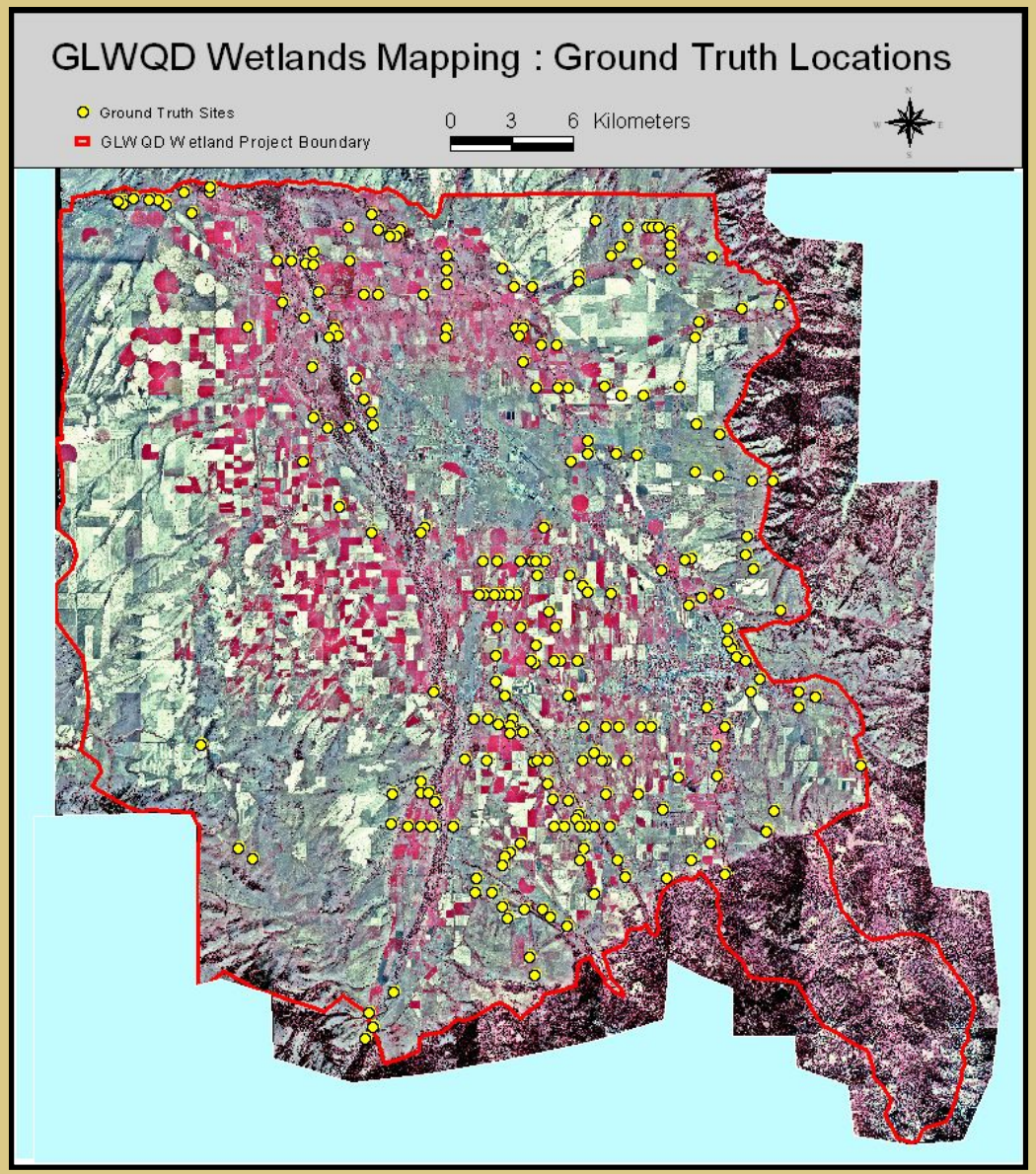
- **Continuous polygons**
  - If the bisecting features still maintained wetland or riparian characteristics they were mapped as a continuous polygon (area).



- **Split polygons**
  - Mapped area was split to exclude the bisecting feature if:
    - Wider than 8 meters, wetland polygon
    - Wider than 15 meters,riparian/wetland mixed polygon

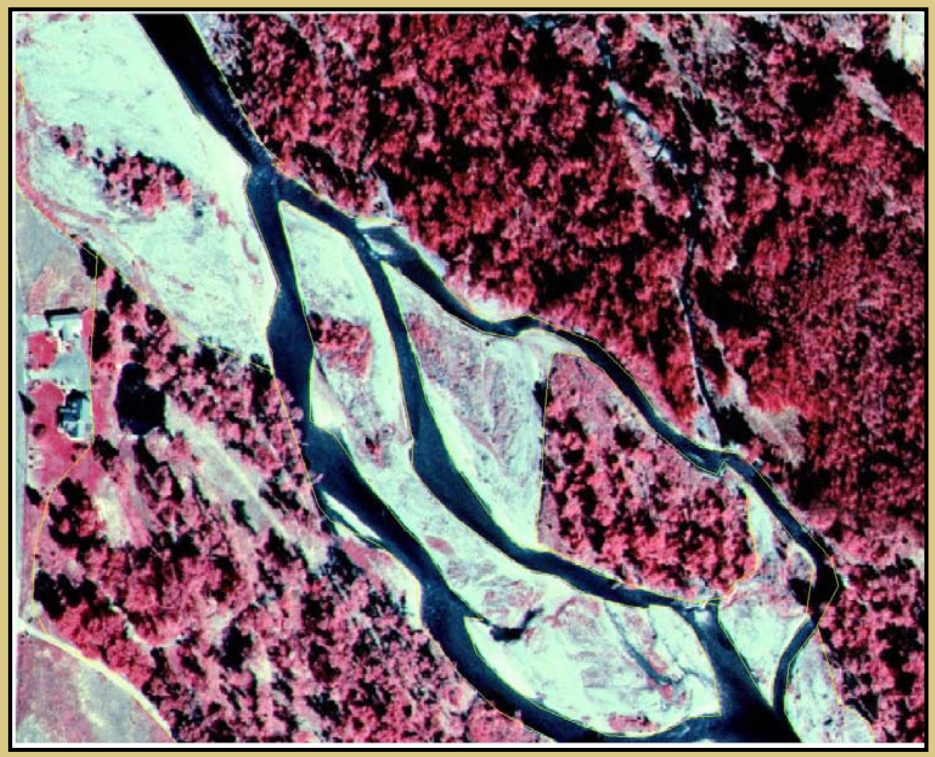


Accuracy Assessment



- 240 sites visited
- On-site data collected:
  - Vegetation species
    - Dominant tree
    - Dominant shrub
  - Visible hydrology
    - Surface
    - Indicators of soil moisture
  - Current land use
  - Evidence of hydrologic alteration
- Aerial observations
  - True color, low altitude photos

Channel Braiding and Flood Scarring on West Gallatin River



Inventory of Gallatin Valley Wetlands in 2001

2001	Total Acres	% of Study Area	Max Size (ac)	Min Size (ac)	Count
Wetlands	8980.85	2.68%	706.45	0.31	401
Riparian	13923.90	4.16%	960.16	0.16	530

- Results
  - Almost 23,000 acres of total wetland / riparian area
  - Over 900 individual wetland / riparian areas

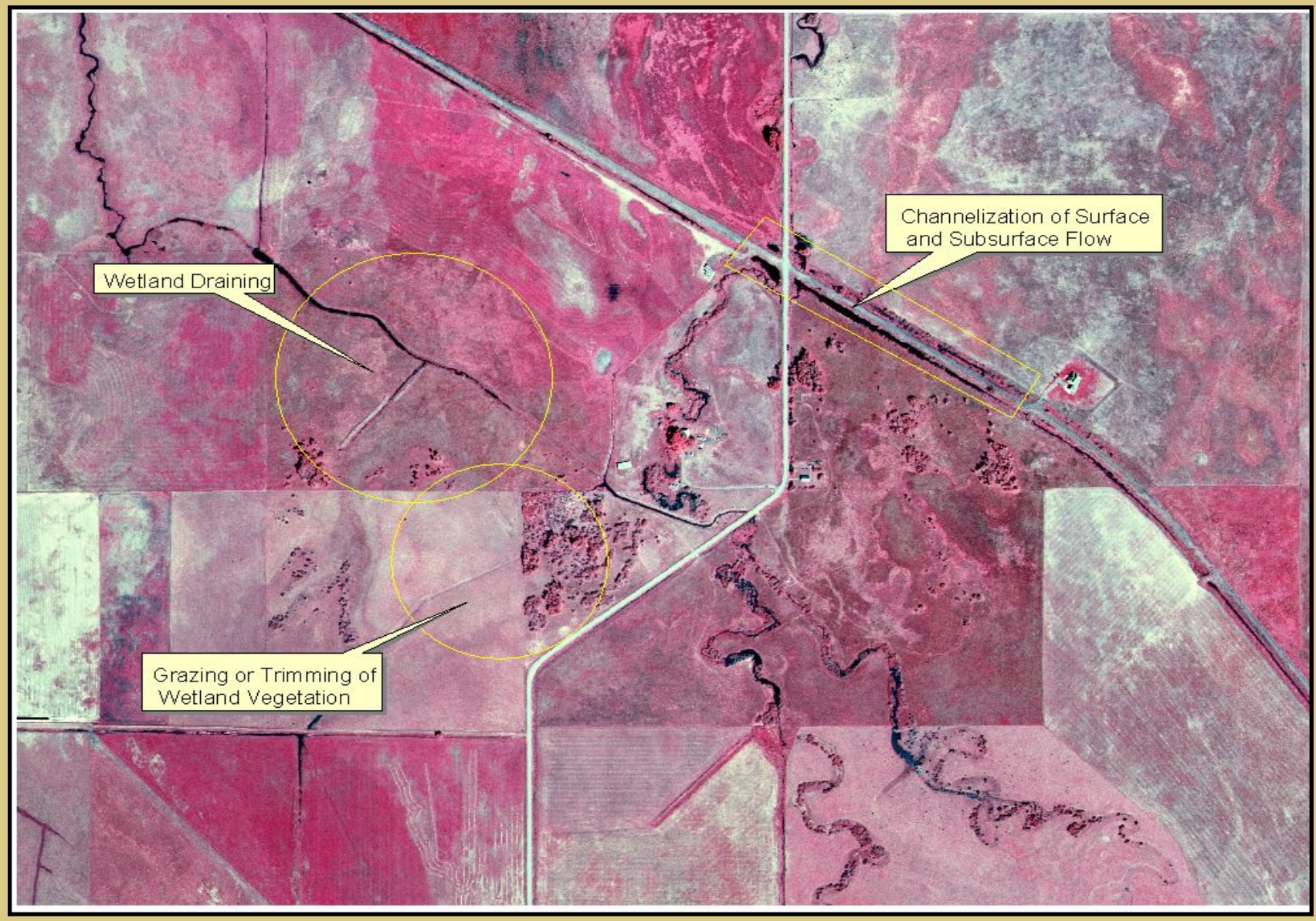
Local Historical Wetland Research

- Conducted by Valerie Harms
- Review of existing literature
  - Lewis & Clark journals
  - Unpublished maps
- Personal interviews with local citizens

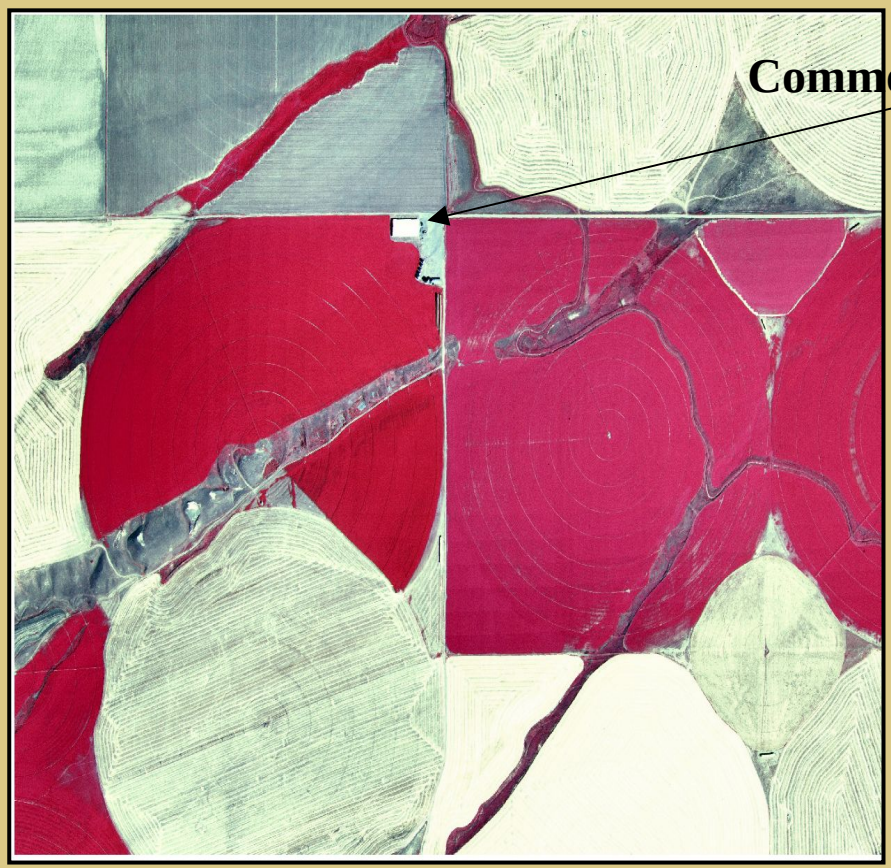
Historical Impacts to Resources

- Trapping, reduction in beaver population
- Agricultural development
  - Draining wet areas, irrigation canals, flood irrigation, cropping, grazing.
- Urban development
  - Draining wet areas, filling wetlands, altering drainage
- Transportation corridors
  - Filling wetlands, altered drainage, blocking surface water flow
- Suburban development
  - Mixture of all other impacts, widespread changes in land use, associated changes in impacts from agriculture.

Evidence of Human Impacts



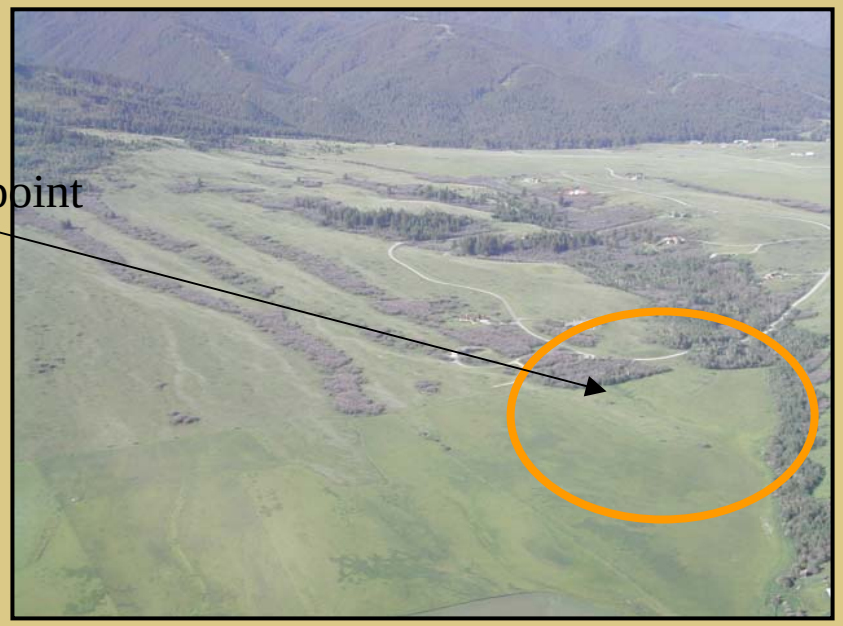
Irrigation Dependent Wetlands



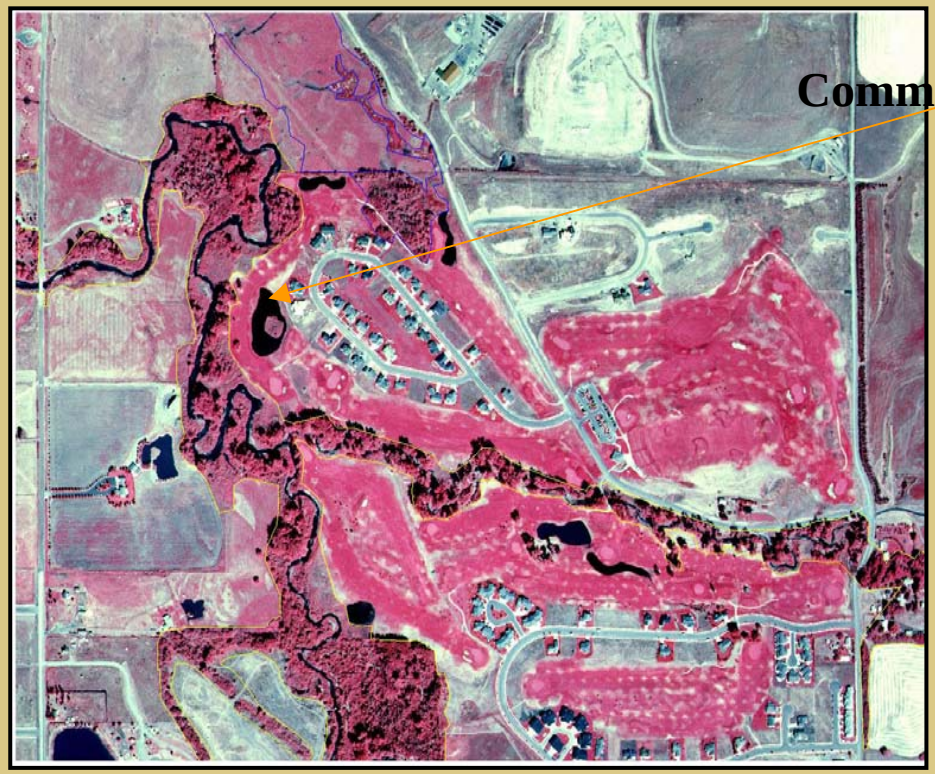
Common point

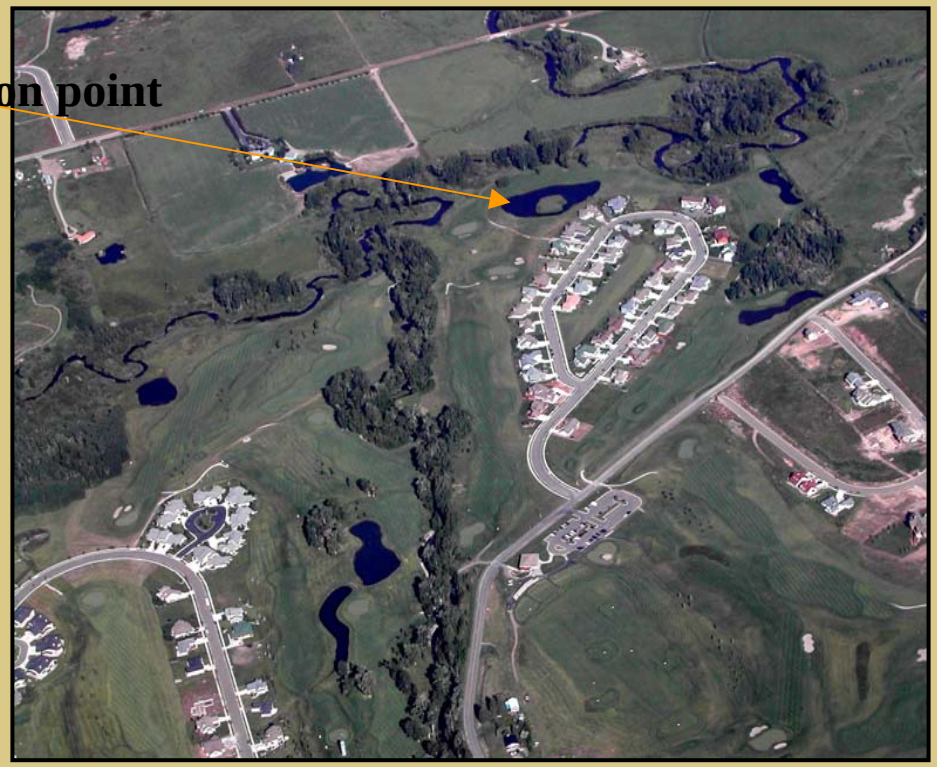
Hawthorne Riparian Area and Land Use Impacts

Common point

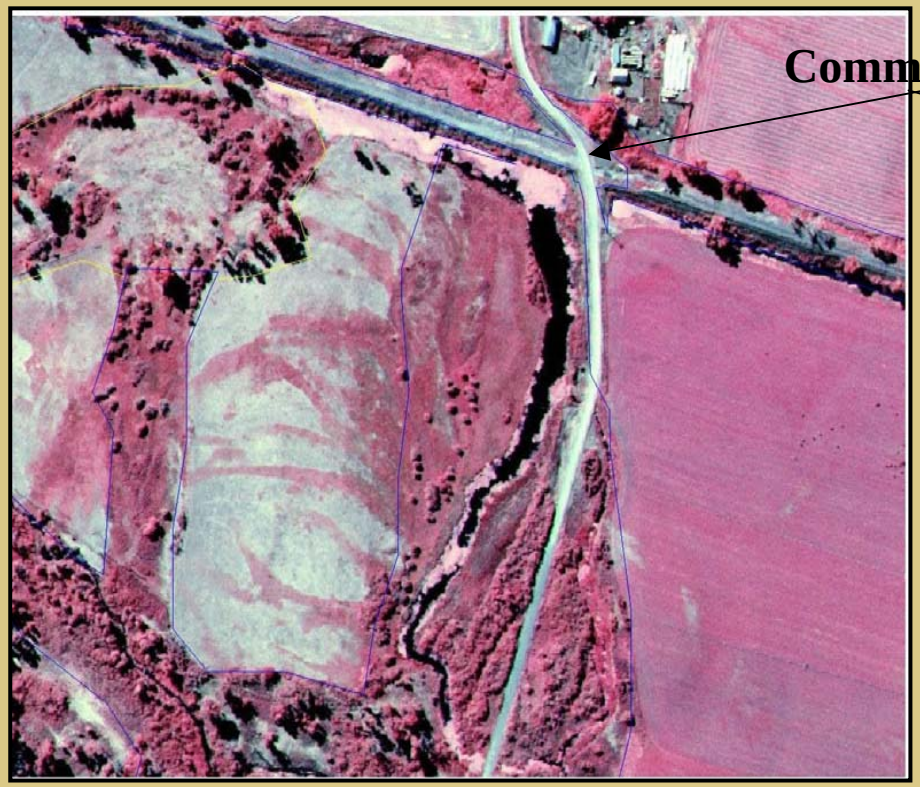


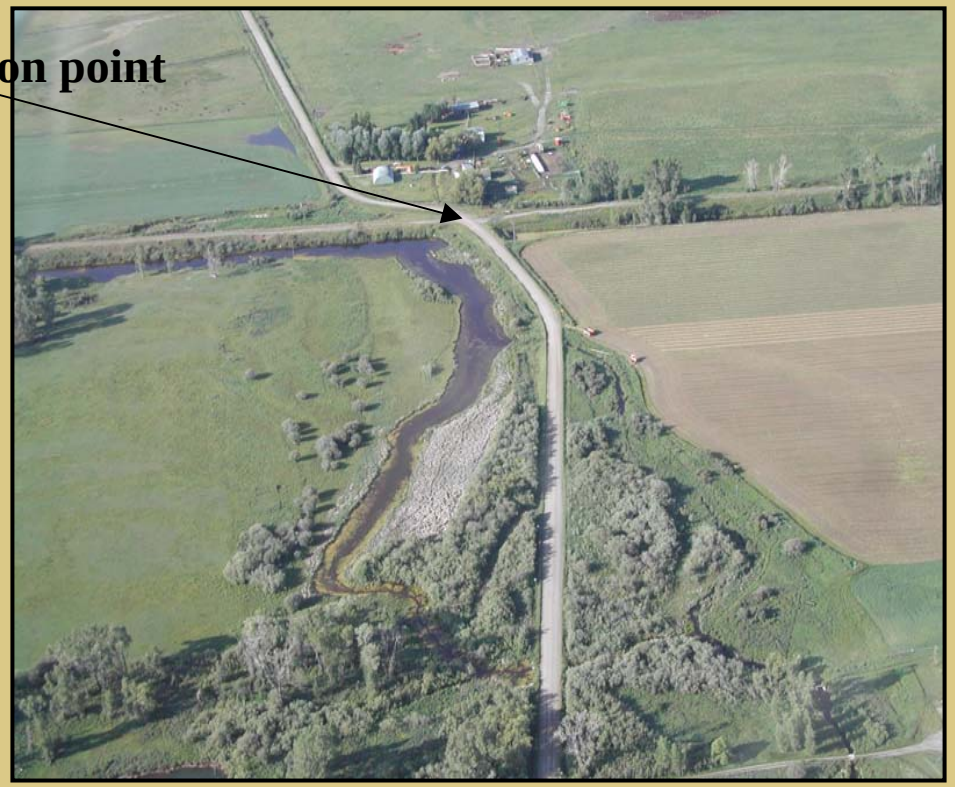
Residential Development in Wetland & Riparian Areas





Roadbeds and Hydrologic Influence





Considerations with NWI

NWI mapping for Gallatin Valley completed using CIR aerial photographs taken in September, 1984 (17 years prior)

Problems

- @ 10-year turn-around time does not provide accurate assessment of current conditions
- Small scale (1:58,000) photos make identification of small wetlands difficult

Successes

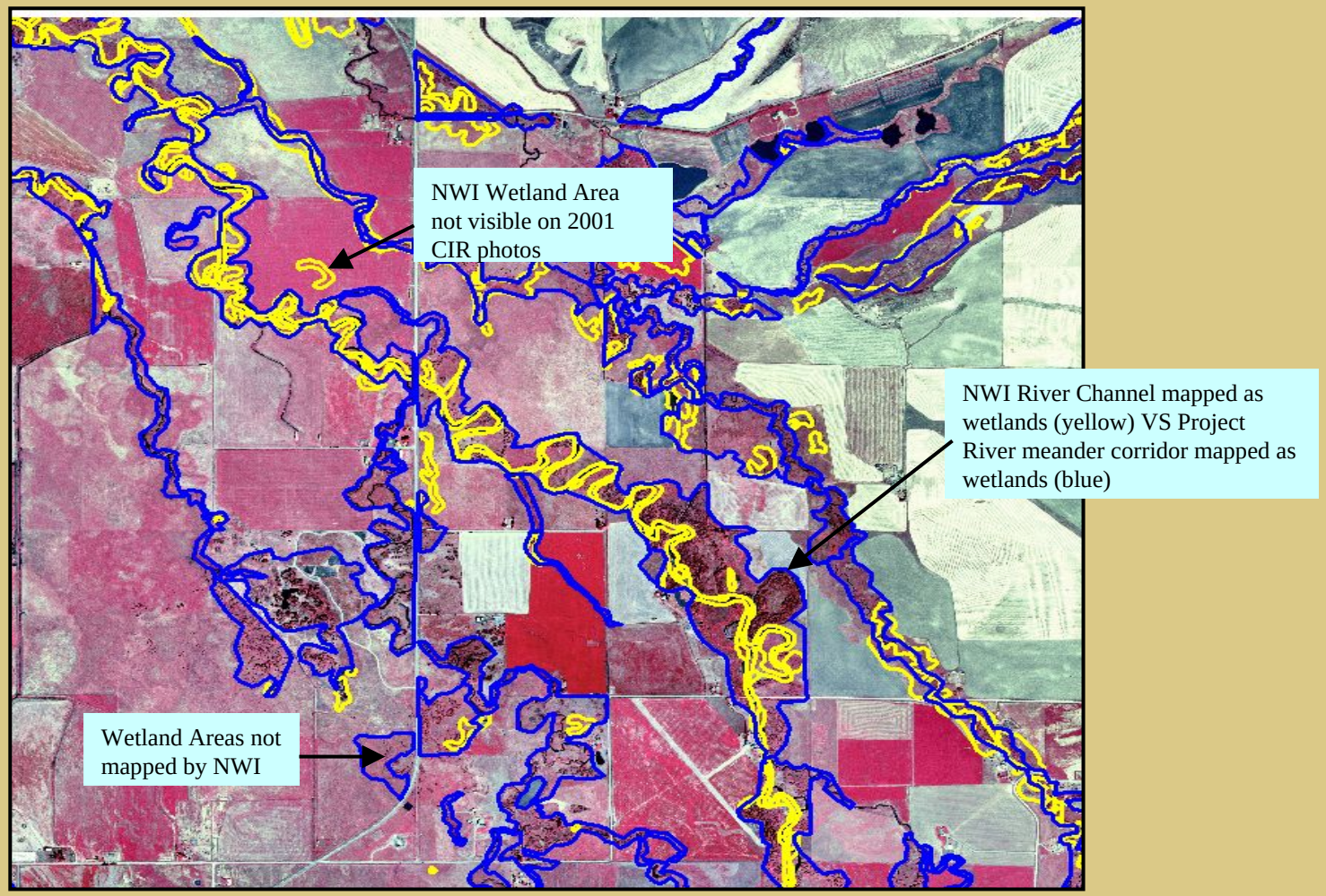
- Able to provide map of wetland distribution over large geographic area
- In addition to location, wetland type is described
- Provides historical record of wetland resources

Comparison of NWI and GLWQD Wetland Maps

NWI 1985	Total Acres	% of Study Area	Max Size (ac)	Min Size (ac)	Count
Wetlands / Riparian	4755.24	1.42%	208.58	0.01	2449

2001	Total Acres	% of Study Area	Max Size (ac)	Min Size (ac)	Count
Wetlands	8980.85	2.68%	706.45	0.31	401
Riparian	13923.90	4.16%	960.16	0.16	530

Comparison of NWI with GLWQD Wetland Layers



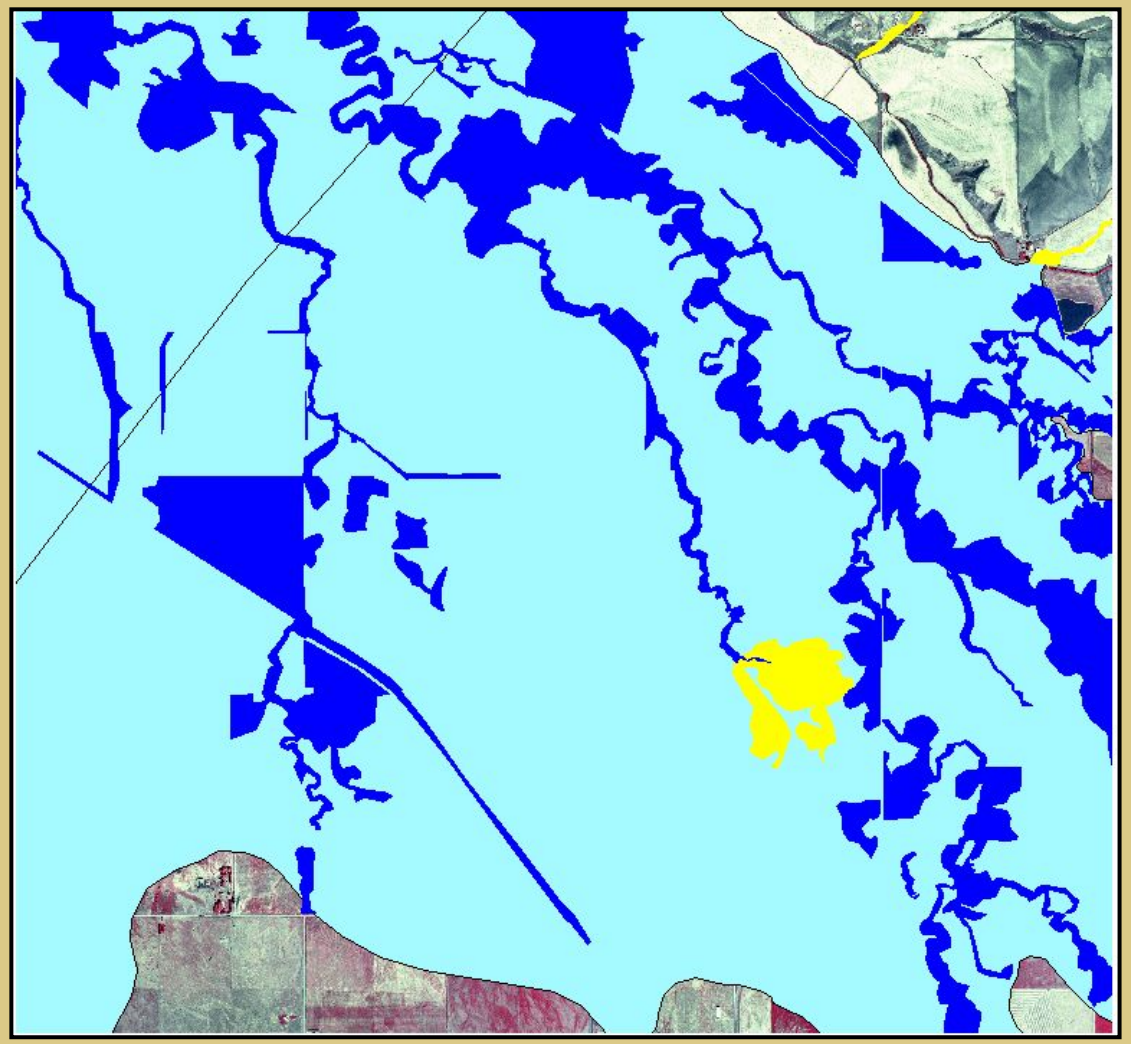
Mapping Maximum Historical Extent of Aquatic Habitats

- Analysis conducted by Curtis Kruer
- Final GIS layer includes ponds, streams and rivers
- Data sources used:
  - National Hydrography Dataset
  - 1937 Aerial Photographs
  - 1959 Aerial Photographs
  - 1995 Digital Orthophotos
  - NRCS Hydric Soils Database
  - FEMA Floodplain Maps
  - Digital Topographic Maps

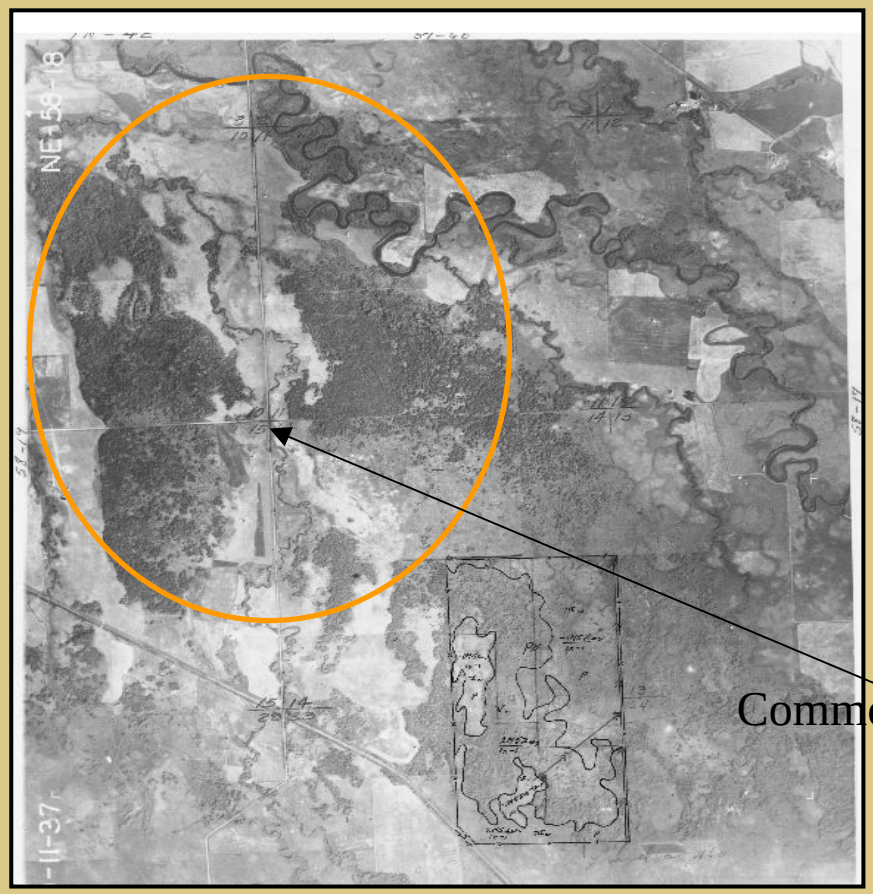
Historical vs Current
East Gallatin Area

Map Legend

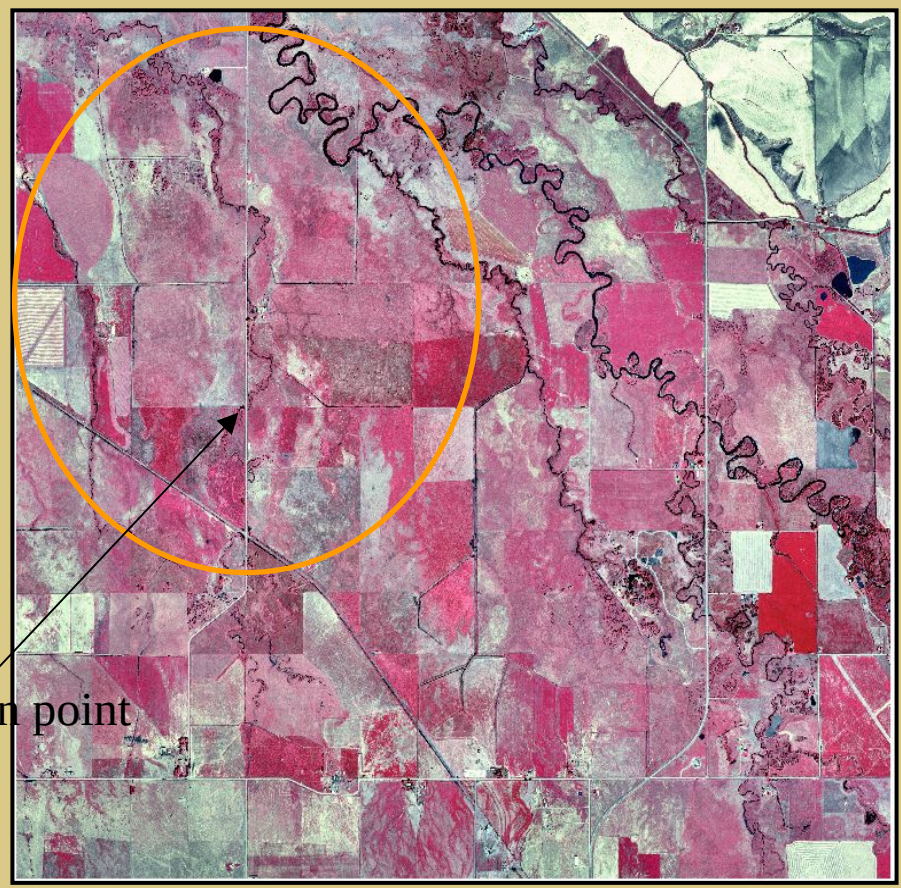
- Riparian/Wetland Mixed (2001)
- Wetlands (2001)
- Maximum Historical Wetland and Riparian Mixed



Riparian / Wetlands In East Gallatin Area: 1937 & 2001



Common point



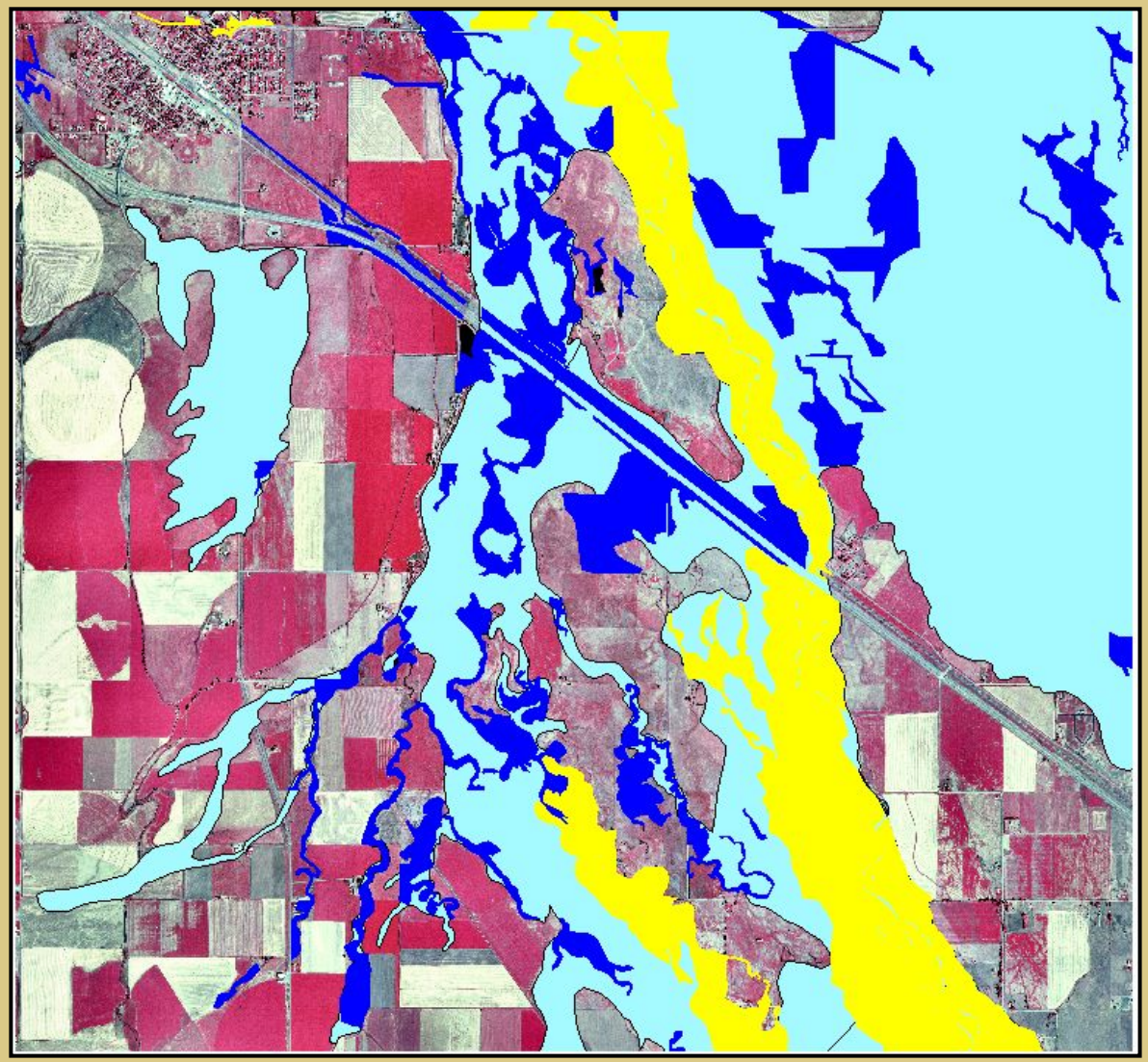
1937 Photo

2001 Photo

Historical vs Current Wetlands at I-90 & West Gallatin Corridor

Map Legend

- Riparian/Wetland Mixed (2001)
- Wetlands (2001)
- Maximum Historical Wetland and Riparian Combined



Comparing Historical Wetland Map to GLWQD 2001Map

Historical Wetlands	Total Acres	% of Study Area	Max Size (ac)	Min Size (ac)	Count
Wetlands / Riparian	59848.68	17.89	17208.41	0.03	381

2001	Total Acres	% of Study Area	Max Size (ac)	Min Size (ac)	Count
Wetlands	8980.85	2.68%	706.45	0.31	401
Riparian	13923.90	4.16%	960.16	0.16	530

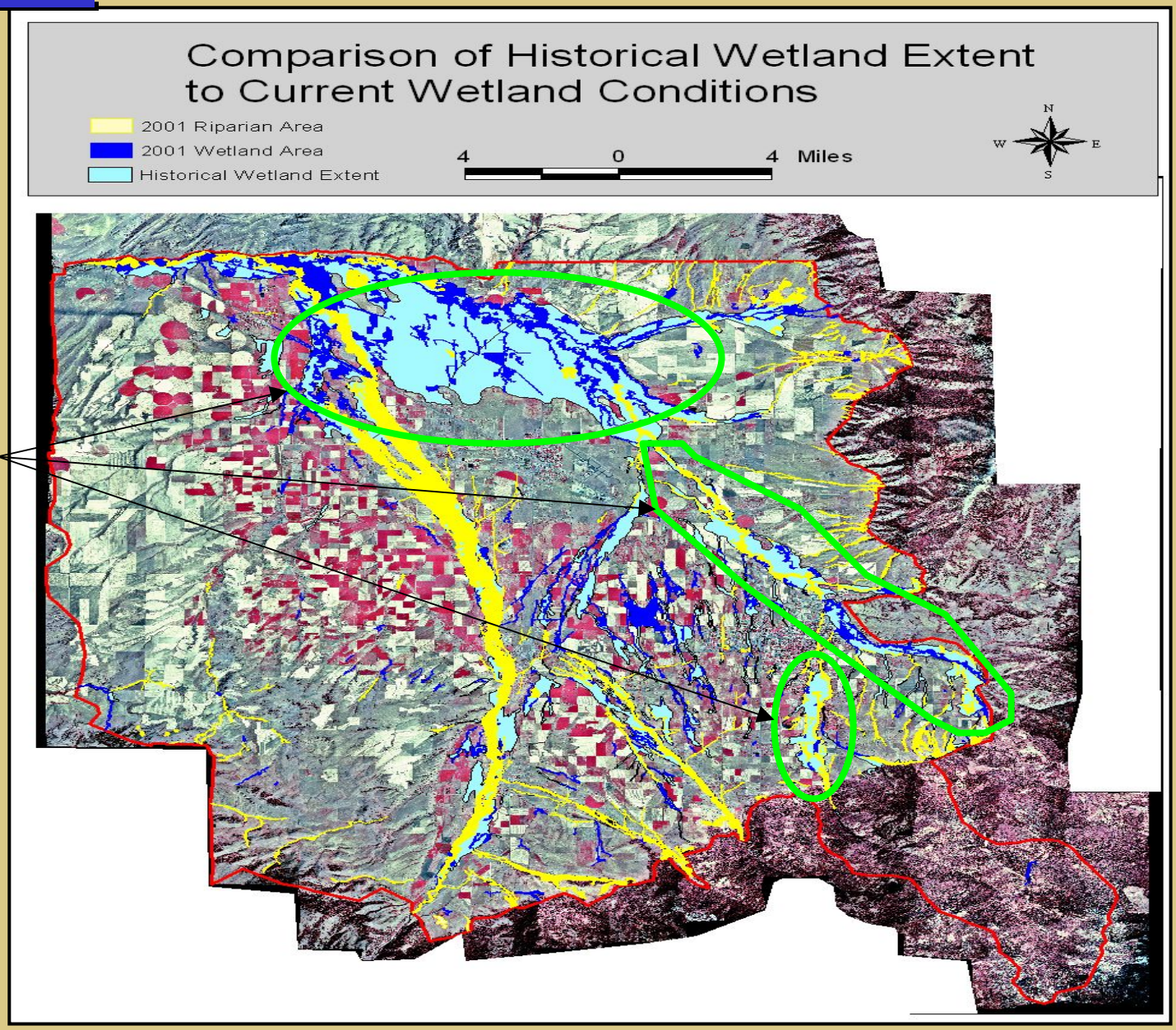
****In 2001, 38% of historical wetlands in Gallatin Valley remain (US average = 46%)**

Potential Project Applications

- Planning and urban development
- Potential model for statewide wetlands mapping project
- Functional assessment of wetlands
  - ACoE Special Area Management Plan (similar work in YNP)
  - DEQ & MNHP [rapid assessment protocols, HGM]
- Baseline data for quantifying future wetland changes
- Wetland protection, restoration and mitigation

Potential Restoration / Protection Sites

Potential areas circled in green



Future Project Considerations

("If we were to do this again...")

- What worked
  - Training with variety of wetland delineation reports
  - Use of complementary ancillary data (existing soils or hydrology GIS data)
  - Visiting various sites before & during mapping *–don't wait to ground truth*
- What to change
  - Use stratified random distribution of ground truth sites
  - Very few ground truth personnel with multiple training sessions

Consideration for State-wide imagery: multispectral digital image data utilizing computer software to classify wetland and riparian features.

Special Thanks

- Gallatin County GIS Department
- Gallatin County Planning Department
- Natural Resource Conservation Service
- Morrison Maierle Environmental Engineering
- US Forest Service
- Lynda Saul - MTDEQ
- Pete Husby – NRCS
- Doug Harrison – NRCS
- Katie Alvin – GCD
- Rick Ladzinski – BWC
- Karin Jennings
- Joe Gutkowski
- Linda Wallace